SSALTO/DUACS
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Nomenclature : -

SSALTO/DUACS User Handbook

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DOCUMENT STATUS SHEET			
Project Control Initials	**ISSUE**	**DATE**	**REASON FOR CHANGE**

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LIST OF ACRONYMS

DAD	Dynamic Auxiliary Data
LWE	Long Wavelength Errors
MSLA	Map of Sea Level Anomaly
MSS	Mean Sea Surface
OE	Orbit Error
OER	Orbit Error Reduction
PF	Polynom Fit
RD	Reference Document
SAD	Static Auxiliary Data
SLA	Sea Level Anomaly

List of tables and figures

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APPLICABLE DOCUMENTS / REFERENCE DOCUMENTS

RD 1 : Reference Document 1
AVISO USER HANDBOOK : SEA LEVEL ANOMALIES (SLA)
Ref : AVI-NT-011-312-CN

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CONTENTS

1. INTRODUCTION

SSALTO/DUACS is the CLS near real time multi-mission altimeter data processing system. It serves the main operational oceanography and climate forecasting centres in Europe and worldwide. SSALTO/DUACS data are used in particular by GODAE and its French contribution Mercator.

Developed and operated by CLS, it started as an European Commission Project (Developing Use of Altimetry for Climate Studies), funded under the European Commission and the Midi-Pyrénées regional council. It is now part of the CNES SSALTO multi-mission ground segment with funding from CNES and the Midi-Pyrénées regional council.

The purpose of this document is to describe the along-track and gridded products (maps) generated by the SSALTO/DUACS Near Real Time altimeter data processing software.

After a description of the input data, a short overview of the processing steps is presented. Then complete information about the SSALTO/DUACS output data (user products) is provided, giving nomenclature, and format description, and software routines.

2. SSALTO/DUACS SYSTEM GENERAL DESCRIPTION

2.1. INTRODUCTION

This chapter intends to present the input data used by SSALTO/DUACS, their center of production, and an overview of the different processing steps necessary to produce the output data.

2.2. DATA USED

2.2.1. Altimetric Data

For TOPEX/Poseidon, the SSALTO/DUACS system uses IGDR data available within 48 hours on the AVISO website (NAVOCEAN data for TOPEX and SSALTO data for Poseidon). ERS2 altimetric data are real time FDP data available within a few hours on the GTS. They are downloaded through the Meteo France IAA database. GFO data are daily IGDR files provided by NOAA with a preliminary MOE orbit. They are usually available within 72 hours. The altimetric data for Jason-1 and ENVISAT are delivered within 48 hours on the SSALTO/CMA data server.

Altimetric product	Source	availability	Type of orbit
TOPEX IGDR	Navocean - AVISO	48h	CNES MOE
Poseidon IGDR	AVISO	48h	CNES MOE
ERS-2 FDP (URA)	Meteo-France	< 1 day	DELFT MOE
GFO IGDR	NOAA	72 h	NOAA MOE
Jason IGDR	AVISO	48 h	CNES MOE
ENVISAT IGDR	AVISO	48 h	CNES MOE

Table 1 : SSALTO/DUACS Input data overview

2.2.2. Dynamic Auxiliary Data

Various Dynamic Auxiliary Data (DAD) are needed to process these altimetric data. The 24 hour ERS2 orbit is computed by the Delft University (Scharroo and Visser, 1998) with dgm-e04. The pressure and wet tropospheric correction grids from the ECMWF model are provided by Meteo France, and the pole tide is computed from IERS data.

2.3. OVERVIEW OF THE SSALTO/DUACS SYSTEM

The purpose of the SSALTO/DUACS system is to produce NRT along-track SLA and NRT maps of SLA combining data from different altimetric missions. The main SSALTO/DUACS processing steps are :

- Acquisition of altimetric data from various altimeter missions in near real time (i.e within a few days at most)
- Validation and correction of the altimetric data sets, i.e. edition and selection, update of corrections and homogenisation, orbit error reduction.
- Production along-track Sea Level Anomaly (SLA) data for each mission.
- Production of maps of Sea Level Anomaly (MSLA). NRT data from all missions are merged into a single map using optimal interpolation and accounting for Long Wavelength errors (Le Traon et al., 1998),(Ducet et al., 2000).

An overview is shown on Figure 1 : SSALTO/DUACS System overview. One can distinguish three different kinds of processing in the SSALTO/DUACS system : continuous processing (acquisition system), daily processing (data enhancement and validation, crossover determination) and weekly processing (product generation).

2.3.1. Acquisition

The acquisition software detects, downloads and processes incoming data as soon as they are available on remote sites (external database, ftp site…). Data are split into passes if necessary (ERS and GFO data input format do not include any Cycle/Pass information). Altimetric data are then synchronized with Dynamic Auxiliary Data such as ERS-2 orbit, pressure and tropospheric correction from ECMWF model fields or pole tide correction. This processing step delivers "raw" data, that is to say data that have been divided into cycles and passes, and ordered chronologically.

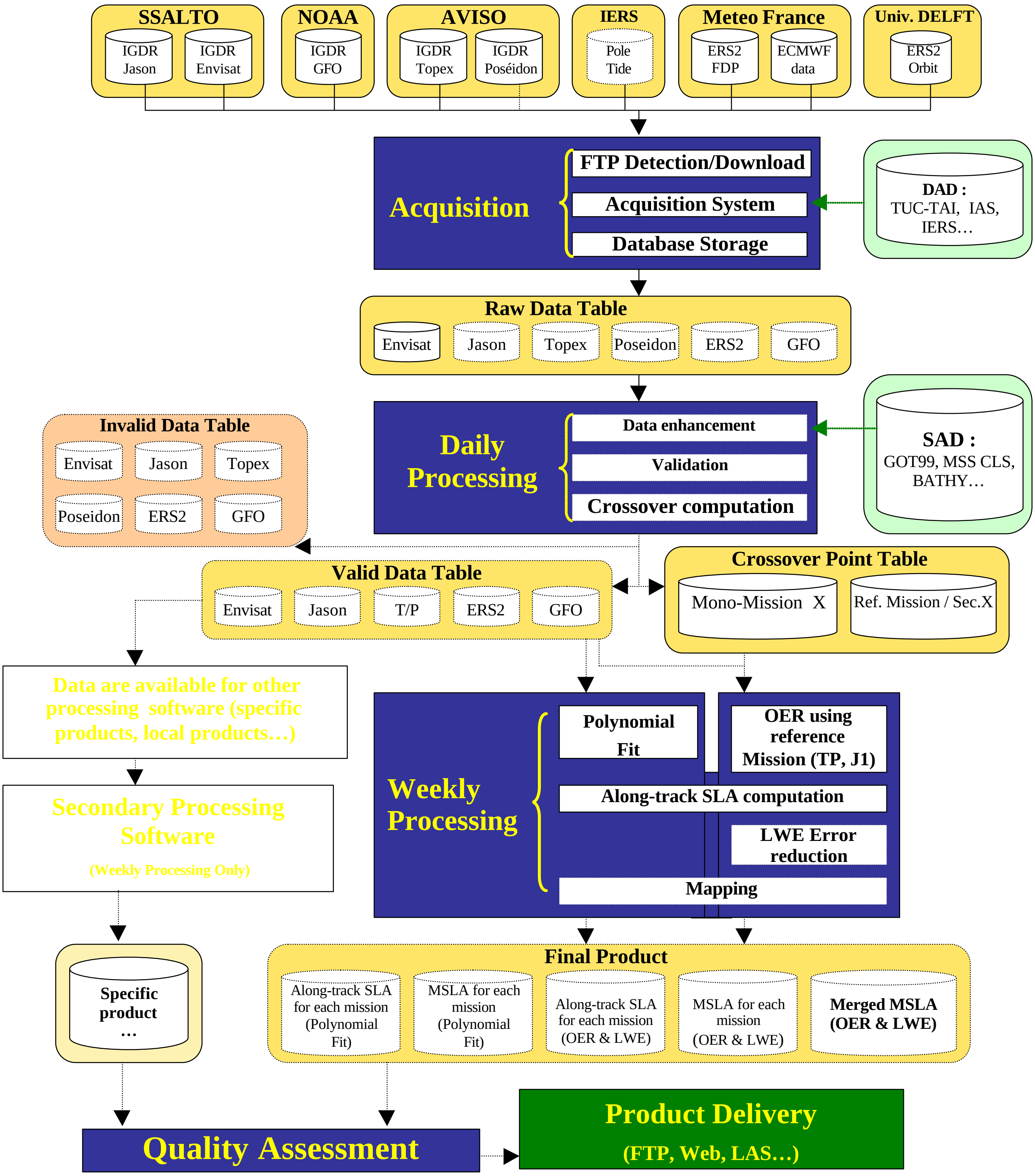

Figure 1 : SSALTO/DUACS System overview

2.3.2. Daily Processing

The main steps of the daily processing consist in data update and enhancement and computation of the crossover data set. Homogeneous geophysical corrections and fields are computed for each altimetric measurement. For instance, the GOT99 (Ray, 1999) ocean tide correction is present in Jason-1 products but TOPEX/Poseidon, ERS2 or GFO data need to be updated with this specific tide correction. Various corrections or homogeneous fields are also computed from other Static Auxiliary Data : CLS 2000 Mean Sea Surface (Hernandez and Schaeffer, 2000), inverse barometer correction using time-varying reference pressure (Dorandeu and Le Traon, 1999)…

Various Cal/Val algorithms are then used on the raw data sets : along-track filtering of the dual-frequency ionospheric corrections (TOPEX, Jason, Envisat), extrapolation of the ERS-2 radiometer correction near the coasts… Then an editing procedure removes data according to validation criteria and methods (quality flags, thresholds, spline fit, abnormal SSH slope detection…).

Mono-satellite and multi-satellite crossover determination is performed on a daily basis. All altimeter fields (measurement, corrections and other fields such as bathymetry, MSS…) are interpolated at crossover locations and dates. Crossovers are then appended to the existing crossover database as more altimetric data become available. This crossover data set will be the input of the Orbit Error Reduction (OER) method in the product generation processing step.

2.3.3. Product Generation

The product generation processing step can be activated once or twice per week to produce along-track Sea Level Anomaly data (SLA) and Maps of Sea Level Anomaly (MSLA). Valid data and crossovers are the inputs of this processing step.

Firstly, a Quality Assessment step is necessary to check the results of the latest Acquisition and Daily Processing. If measurement errors remain after the previous validation step, they can be detected and corrected before the product generation step.

Two different orbit error reduction methods are systematically used and run in parallel. The first one represents the nominal processing. It uses precise Orbit Error Reduction (OER) methods adjusting less precise orbits by reference to a more precise mission (reference mission). Then a Long Wavelength Errors (LWE) determination is performed.

The second one (PF) is much simpler and faster. Polynomial functions are fitted along each pass to estimate and remove long wavelength signals, including orbit errors. This processing is mainly used to produce quickview data for the quality assessment step, but it also allows product delivery in case of unavailability of altimeter data from the reference mission.

2.3.3.1. Orbit Error Reduction method (OER) and LWE

The crossover database is first used to reduce the orbit errors for the reference mission (T/P, Jason-1). An orbit error model based on one and two cycles per revolution sinusoidal functions is fitted to the crossover differences by global minimization. Then multi-mission crossover differences (T/P – ERS2 or T/P – GFO for instance) are also minimized by a multi-satellite orbit error determination using spline functions. This software was specifically designed for missions that do not have a very accurate orbit determination (ERS-2, GFO…) (Le Traon et al., 1995),(Le Traon and Ogor, 1998). Using the precision of the reference mission orbit, a very accurate orbit error can be estimated.

The along-track Sea Level Anomalies are then computed in three main steps : individual measurements are resampled along a theoretical track (Mean Track) associated to each mission. Then a Mean Profile is subtracted from the resampled data to obtain SLA. The Mean Profile is a time average of similarly resampled data over a long period. The mean profile used for the TOPEX/Poseidon and Jason-1 track has been computed with data from January 1993 to December 1999. The mean profile used for ERS2/ENVISAT has been computed over a five year period corresponding to the T/P Mean Profile. A specific processing has been used to ensure that it is consistent with the T/P Mean Profile (reduction of orbit error and correction of ocean variability). The Mean Profile used for GFO has been computed with GEOSAT (ERM) data over a 2 year period with a specific processing similar to the one used for ERS2 (Hernandez et al., 2000). SLA are then edited to remove remaining erroneous measurements.

SLA are then along-track filtered to remove measurement noise. They are sub-sampled to speed up the LWE and mapping steps (see below). A Long Wavelength Errors determination software is then used to ensure additional consistency between data from different passes of the same mission and/or data from different altimeter missions (Le Traon et al., 1998). Both remaining orbit errors and high frequency signals are thus estimated in this procedure. They are subtracted from the along-track SLA to produce the final OER along-track product.

A mapping procedure using Optimal Interpolation with realistic correlation functions is then applied to produce a SLA map at a given date. The procedure generates one map for each altimeter mission but also a combined map merging measurements from all available altimeter missions. Combining data form different missions significantly improves the estimation of mesoscale signals (Le Traon and Dibarboure, 1999), (Le Traon et al., 2001).

2.3.3.2. Polynomial fit (PF)

This second processing is much simpler and faster than the Orbit Error Reduction. Neither OER by crossover differences minimization nor LWE determination are performed in this case. Polynomial functions are directly fitted to the SLA instead. This estimation is then subtracted from the SLA as soon as they have been computed (using the same Mean Profile as OER products). Therefore, the PF along-track and gridded products can be considered as mesoscale-only products.

3. SSALTO/DUACS PRODUCTS

3.1. OVERVIEW

Two types of products are delivered by the SSALTO/DUACS system :

- SLA with precise Orbit Error Reduction and Long Wavelength Error reduction (OER products),
- SLA computed with a fit of polynomial functions (PF products).

In both cases, the following products are generated :

- Along-track SLA (one file per altimeter mission). The storage format used is presented in chapter 4.2, and the software routines needed to read this product are presented in chapter 5.2.
- A SLA map for each altimeter mission with its formal mapping error. These products are available in NetCDF format. The conventions used are presented in chapter 4.3, and the software routines needed to read this product are presented in chapter 5.3.

The OER processing steps also generates a map merging all altimeter data available in NRT, and from all altimeter missions. A map of geostrophic velocities deduced from the SLA map is also available in NetCDF format.

The grid used for all maps is a 1/3° Mercator projection grid, i.e :

$M_{I0,J0}=(0°, 0°)$ and $M_{I,J} = (X , Y)$

With :

$X = \Delta X * I$ where $X \in [0°,360°]$ and $I \in [0,1079]$

and

$Y = \sum_{k=0}^{J} \Delta Y_k$ where $Y \in [-82°,82°]$ and $J \in [-457,457]$

and

$\Delta X = 1/3°$

$\Delta Y_J = \Delta X * \cos(\Phi_J)$

where $\Phi_J = 180 / \pi * \arcsin[\tanh(\Delta X * \pi / 180 * (J - J_0))]$

During the system validation period, the main SLA map (merged OER product) will be resampled on a 0.25° regular grid and distributed on the historical DUACS MSLA format in ASCII. This format is presented in chapter 4.4, and the software routines needed to read this product are presented in chapter 5.

3.2. NOMENCLATURE

All SSALTO/DUACS filenames use only lower case characters.

3.2.1. Along-track SLA files

The nomenclature used for the along-track SLA is :

res_{*PROCESSING_USED*}_{*MISSION*}_{*DAY_BEGINNING*}_{*DAY_END*}.bin

where :

PROCESSING_USED is :

- **oer** for products generated by the Orbit Error Reduction processing (cf. 2.3.3.1),
- **pf** for products generated by the Polynomial Fit processing (cf. 2.3.3.2).

MISSION is :

- **tp** for TOPEX/Poseidon Sea Level Anomaly,
- **e2** for ERS2 Sea Level Anomaly,
- **g2** for GFO Sea Level Anomaly,
- **j1** for Jason-1 Sea Level Anomaly,
- **en** for ENVISAT Sea Level Anomaly.

DAY_BEGINNING is the date of the data set beginning in CNES Julian days (truncated to the lower integer).

DAY_END is the date of the data set end in CNES Julian days (truncated to the lower integer).

Examples of SLA filenames :

res_oer_tp_19015_19028.bin – TOPEX/Poseidon SLA file containing data from 23rd, January 2002, to 05th February 2002, generated by the Orbit Error Reduction processing.

res_pf_g2_19008_19021.bin – GFO SLA file containing data from 16th, January 2002, to 29th January 2002, generated by the PF processing.

3.2.2. NetCDF Maps

The nomenclature used for the NetCDF grids is :

msla_{*PROCESSING_USED*}_{*MISSION*}_{*GRID_TYPE*}_{*DAY_MAP*}[_{*OPTION*}].nc

where :

PROCESSING_USED is :

- **oer** for products generated by the Orbit Error Reduction processing (cf. 2.3.3.1),
- **pf** for products generated by the Polynomial Fit processing (cf. 2.3.3.2).

MISSION is :

- **tp** for TOPEX/Poseidon maps,
- **e2** for ERS2 maps,
- **g2** for GFO maps,
- **j1** for Jason-1 maps,
- **en** for ENVISAT maps,
- **merged** for maps where all NRT available data from all altimeter missions have been combined.

GRID_TYPE shows the type of data in the NetCDF file :

- **h** for a MSLA map in cm (data available in Grid #1, cf. 4.3),
- **err** for a map of formal mapping error in percentage of signal variance (data available in Grid #1, cf. 4.3),
- **uv** for maps of geostrophic velocities in cm/s (U is available in Grid #1 and V in Grid #2, cf. 4.3).

DAY_MAP is the map date in CNES Julian days (0h).

OPTION is optional and may contain :

- **qd** for maps that have been resampled on a regular 0.25° grid,
- **lr** for low resolution products where short wavelength signals have been removed.

Examples of NetCDF map filenames :

msla_oer_tp_h_19015.nc – Map of Sea Level Anomaly on 23rd January 2002, based on TOPEX/Poseidon data and generated by Orbit Reduction Processing.

msla_pf_g2_uv_19015_lr.nc – Low resolution map of geostrophic velocitites on 23rd January 2002, based on GFO data and generated by the PF processing.

3.2.3. ASCII Maps

The nomenclature used for the NetCDF grids is :

msla_{*PROCESSING_USED*}_{*MISSION*}_{*GRID_TYPE*}_{*DAY_MAP*}[_{*OPTION*}].asc

where :

PROCESSING_USED is :

- **oer** for products generated by the Orbit Error Reduction processing (cf. 2.3.3.1),
- **pf** for products generated by the Polynomial Fit processing (cf. 2.3.3.2).

MISSION is :

- **tp** for TOPEX/Poseidon maps,
- **e2** for ERS2 maps,
- **g2** for GFO maps,
- **j1** for Jason-1 maps,
- **en** for ENVISAT maps,
- **merged** for maps where all NRT available data from all altimeter missions have been combined.

GRID_TYPE shows the type of data in the ASCII file :

- **h** for a map of SLA in mm and a map of formal mapping error in percentage of signal variance (cf. 4.4),
- **uv** for maps of geostrophic velocities in mm/s (cf. 4.4).

DAY_MAP is the map date in CNES Julian days (0h).

OPTION is optional and may contain :

- **qd** for maps that have been resampled on a regular 0.25° grid,
- **lr** for low resolution products where short wavelength signals have been removed.

Examples of ASCII filenames :

msla_oer_tp_h_19015.asc – Map of Sea Level Anomaly on 23rd January 2002, based on TOPEX/Poseidon data and generated by Orbit Reduction Processing.

msla_pf_g2_uv_19015_lr.asc – Low resolution map of geostrophic velocitites 23rd January 2002, based on GFO data and generated by the PF processing.

4. DATA FORMAT

4.1. INTRODUCTION

This chapter presents the data storage format used for SSALTO/DUACS products : along-track Sea Level Anomalies, NetCDF maps and ASCII maps (0.25° maps that have been resampled from the original 1/3° Mercator grid).

4.2. ALONG-TRACK SLA

This format is strictly identical to the storage format used for other SLA files available through AVISO. It is presented in Appendix A. This Appendix is an extract from the Reference Document #1. The complete document is available on the AVISO website.

http://www-aviso.cnes.fr:8090/HTML/information/frames/publication/hdbk/sla/hdbk312_frm_uk.html

Software routines needed to read this product are presented in chapter 5.2.

4.3. NETCDF MAPS

4.3.1. NetCDF

SSALTO/DUACS maps are stored using the NetCDF (Network Common Data Form), a generic and multi-platform format developed by Unidata. An exhaustive presentation of NetCDF and additional conventions is available on the Unidata website :

http://www.unidata.ucar.edu/packages/netcdf/index.html

4.3.2. Structure and semantic of SSALTO/DUACS files

All basic NetCDF conventions are applied to SSALTO/DUACS files. In addition to these conventions, the SSALTO/DUACS files are using a common structure and semantic :

- 4 Dimensions are defined :

LatLon: is always 2. It is used to check NetCDF variables depending on latitude and longitude.

NbLatitudes: contains the number of grid points along latitude.

NbLongitudes: contains the number of grid points along longitude.

GridDepth: contains the number of values available in each grid point, and for each grid defined (it represents the number of grid "layers"). SSALTO/DUACS files always contain only one layer grids so GridDepth is 1. If this dimension is missing, it is considered to be equal to 1.

- 2 Variables are used for all grids defined below :

  double **LatLonMin(LatLon)**: contains the minimum values for latitude and longitude (south-west corner).

  double **LatLonStep(LatLon)**: contains the latitude and ~~then~~ longitude resolution (ΔY and ΔY for regular grids and ΔYo and ΔYo (equator values) for Mercator grids).

  Constraints :

  LatitudeMin+LatStep*NbLatitudes <= 90 (<=89 for Mercator grids)

  LonStep*NbLongitudes <= 360.

- A grid file may contain as many files as needed although most SSALTO/DUACS contain only one (H, Mapping Error) or two (U/V) grids.

  All grids must have the same Lat/Lon/Depth dimensions defined above, even if each grid can have other specific attributes (default value, unit…). Grids are stored as [Lon, Lat] arrays in C or [Lat, Lon] arrays in Fortran, that is to say by increasing latitude and longitude, with each data set divided into longitude "slices" of consecutive latitude values. Each grid is identified by grid number, that is to say a unique four digit unsigned integer value.

Grid_nnnn(NbLongitudes, NbLatitudes): grid variable with grid number equal to nnnn and with only one layer.

Grid_nnnn(NbLongitudes, NbLatitudes, GridDepth): grid variable with grid number equal to nnnn and with GridDepth layers.

The global attribute **FileType** defines the type of grid. There are currently 4 types of grids : DOTS, BOXES, DOTS_MERCATOR and BOXES_MERCATOR. The SSALTO/DUACS maps are stored on DOTS_MERCATOR grids.

'**GRID_DOTS**': values are defined as POINTS. Each value has been computed exactly on the Lat/Lon values defined by LatLonMin and LatLonStep.

'**GRID_BOXES**': values are defined as BOXES. A single grid box represents the whole area from Latitude and longitude index |i,j] to index [i+1,j+1].

'**GRID_DOTS_MERCATOR**': this grid type similar to GRID_DOTS, but the grid definition in latitude is not linear with the latitude index. The Latitude and Longitude values are defined as in 3.2.2.

'**GRID_BOXES_MERCATOR**': this grid type similar to GRID_BOXES, but the grid definition in latitude is not linear with the latitude index. The Latitude and Longitude values are defined as in 3.2.2.

Examples of NetCDF grid file (MSLA TP on a 1/3° Mercator grid)

```
netcdf msla_ tp_h_19015.nc {
dimensions:
    LatLon = 2 ;
    NbLatitudes = 915 ;
    NbLongitudes = 1080 ;
    GridDepth = 1 ;
variables:
    double LatLonMin(LatLon) ;
        LatLonMin:_FillValue = 1.84467440737096e+19 ;
        LatLonMin:long_name = "Latitude/Longitude of south/ouest corner" ;
        LatLonMin:units = "degree" ;
```

```
        double LatLonStep(LatLon) ;
                LatLonStep:_FillValue = 1.84467440737096e+19 ;
                LatLonStep:long_name = "latitude/longitude steps" ;
                LatLonStep:units = "degree" ;
        float Grid_0001(NbLongitudes, NbLatitudes) ;
                Grid_0001:_FillValue = 1.844674e+19f ;
                Grid_0001:long_name = "SLA" ;
                Grid_0001:units = "cm" ;

// global attributes:
                :FileType = "GRID_DOTS_MERCATOR" ;
                :OriginalName = " msla_ap_tp_h_19015.nc " ;
                :CreatedBy = "SSALTO/DUACS" ;
                :CreatedOn = "04-FEB-2002 23:33:17" ;
                :title = " NRT SLA T/P – 2002/01/23" ;
data:

 LatLonMin = -82, 0 ;

 LatLonStep = 0.333333333333333, 0.333333333333333 ;

 Grid_0001 =
   _, _, _, _, _, _, _, _, _, -1.119989, -1.191618, -1.24841, -1.244721,
   -0.9649581, -0.592562, 0.04207221, 0.8542445, 1.336711, 1.810621,
   1.906609, 1.767064, 1.736634, 1.394857, 1.033213, 0.6763388, 0.3328404,
   -0.07905415, -0.5154375, -0.9471657, -0.7384071, -0.6251237, -0.6695364,
…..
```

Software routines needed to read this product are presented in chapter 5.3.

4.3.3. Grid numbers used by SSALTO/DUACS

MSLA maps (in cm) are stored in grid number 0001 of NetCDF files. Formal mapping error maps (in percentage of variance signal) are stored in grid number 0001. Geostrophic velocity maps (in cm/s) are stored in grid numbers 0001 (U) and grid number 0002 (V)

4.4. ASCII MAPS

An ASCII map file can be divided into two parts : header and data. The header is composed of two lines containing :

- The map title (80 character string)
- The grid definition (Integer x 2, Real x 2, Integer x 2) with the south-west point location (latitude, longitude) in degrees, the latitude then longitude resolution, and the number of grid points in latitude and longitude.

The data set itself uses one line for each grid point. They are stored as [Lon,Lat] arrays in C or [Lat,Lon] arrays in Fortran, that is to say with increasing latitude and longitude with longitude "slices" where two latitudes are consecutive.

Each data line contains two integers :

- The SLA value in mm and the corresponding formal mapping error in percentage of signal variance (H, Error maps).
- Or the value or U then V in mm/s (geostrophic velocity maps)

Example of ASCII grid (¼° map)

line number : Content

1 : NRT SLA and mapping error T/P 2001/11/07

2 : -82 0 0.250 0.250 656 1440

3 : -5 4

4 : 17 5

5 : 29 8

6 : …

Software routines needed to read this product are presented in chapter 5.4.

5. SOFTWARE ROUTINES

5.1. INTRODUCTION

This chapter intends to give a link to various software routines able to read SSALTO/DUACS products. It is possible to plug these codes into programs in C or Fortran or to reproduce them in other languages.

5.2. ALONG-TRACK SLA

These routines are distributed by AVISO and are able to read all SLA files. They are available in Fortran 77 and can be downloaded on the AVISO ftp site :

ftp://ftp.cls.fr/pub/oceano/AVISO/DUACS/SOFTWARE/READVMS_RES.FOR.gz

for OpenVMS / Linux intel / Little Indian unix computers

ftp://ftp.cls.fr/pub/oceano/AVISO/DUACS/SOFTWARE/READUNIX_RES.f.gz

for Unix SUN / Big Indian unix computers

5.3. NETCDF MAPS

The routines needed to read maps stored in NetCDF (as well as a sample program and a sample NetCDF file with ASCII dump) are available on the AVISO ftp site :

ftp://ftp.cls.fr/pub/oceano/AVISO/DUACS/SOFTWARE/PublicReadGridDelivery.tar.gz

5.4. ASCII MAPS

An example of Fortran 77 program able to read this simple ASCII format is available on the AVISO ftp site :

ftp://ftp.cls.fr/pub/oceano/AVISO/DUACS/SOFTWARE/READ_MSLA.FOR.gz

APPENDIX : EXTRACT FROM THE AVISO USER HANDBOOK

5.4 SLA files

5.4.1 Labelling and brief description

TYPE	Integer binary (VMS)
RECORD LENGTH (fixed)	**RL** bytes
SIZE	**RS** MB megabytes

Each file is integer binary file with a fixed record length of RL bytes and a size of RS megabytes depending on the satellite mission and the associated repeat-cycle. The type of all variables is integer, DEC binary data format.

The RL record length of a SLA file depends on the number of cycles used:

RL = 8 + (Cycle_Count*2) + (MOD(Cycle_Count,2)* 2)

RL	Record length (in bytes)
Cycle_Count	Number of cycles used to create the SLA file
MOD	Modulo function

For instance:

For ERS-1, phace C, cycles 6 to 18 (E1 c - SLA)	RL = (13 cycles*2+1*2) = 36 bytes
For TOPEX/POSEIDON, cycles 113 to 149 with cycle 118 missing, i.e. 37-1 cycles	RL = (36 cycles*2+0*2) = 72 bytes

(T/P - SLA 4)	

The **RS** size of a SLA file depends on the satellite and the number of cycles used.

for TOPEX/POSEIDON, it is about:	**RL * 0.5 (Repeat-cycle)$_{\textbf{TOPEX/POSEIDON - 10 day}}$**
for ERS, it is about:	**RL * 1.9 (Repeat-cycle)$_{\textbf{ERS - 35 day}}$**

5.4.2 File organization

SLA products are organized a file per year (or near a year), data recorded per passes. Pass data contains data information in a header line, a cycle list and a series of scientific data records:

GENERAL HEADER RECORD	
1 st PASS	PASS HEADER record ---------------------- Cycle list (N_1 cycles) ------------------------ DATA records latitude, longitude Scientific data record 1 .../... Scientific data record N_1
2nd PASS	PASS HEADER record ---------------------- Cycle list (N_2 cycles) ---------------------- DATA records latitude,

	longitude Scientific data record 1 .../...
LAST PASS	PASS HEADER record --------------------- Cycle list (N_{last} cycles) --------------------- DATA records latitude, longitude Scientific data record 1 .../... Scientific data record N_{last}

GENERAL HEADER RECORD

Field Number	***Record Location***	***Mnemonic***	***Content***	***Type***	***Size***	***Units***
1	**1**	Pass_Count	Total number of passes	SI	2	/
2	**3**	Cycle_Count	Total number of cycles	SI	2	/
3	**5**	Repetitivity	Repeat-cycle	SI	4	10^{-4} day
4	**9**	Spare	/	/	RL-8	/

PASS HEADER RECORD

Field Number	***Record Location***	***Mnemonic***	***Content***	***Type***	***Size***	***Units***

1	**1**	Pass_Number	Pass number	SI	2	/
2	**3**	Cycle_Count_Pass	Total number of cycles for the pass(N)	SI	2	/
3	**5**	MeanDay	Mean day of first cycle	SI	4	10^{-2} day
4	**9**	NbPts	Total number of points	SI	2	/
5	**11**	Spare	/	/	RL-10	/

CYCLE LIST RECORD CONTENT

Field Number	***Record Location***	***Mnemonic***	***Content***	***Type***	***Size***	***Units***
1	**1**	Cycle_Number 1	Cycle number 1	SI	2	/
2	**3**	Cycle_Number 2	Cycle number 2	SI	2	/
N	**5**	Cycle_Number N	Cycle number N	SI	2	/
N+1	**7**	Spare	/	/	RL-2N	/

DATA RECORD CONTENT

Field Number	***Record Location***	***Mnemonic***	***Content***	***Type***	***Size***	***Units***
1	**1**	Lat_Tra	Latitude	SI	4	10^{-6} deg

2	**5**	Lon_Tra	Longitude	SI	4	10^{-6} deg
3	**9**	SLA_1	Sea Level Anomaly	SI	2	mm
4	**11**	SLA_2	Sea Level Anomaly	SI	2	mm
N	**13**	SLA_N	Sea Level Anomaly	SI	2	mm
N	**15**	Spare	/	/	0 or 2*	/

Spare size is (Cycle_Count **-** *Cycle_Count_Pass)*2 + MOD(Cycle_Count,2)*2*

SI *Signed Integer*